Three-Dimensional Backscatter X-Ray

In-Space Non-Destructive Inspection Technology Workshop

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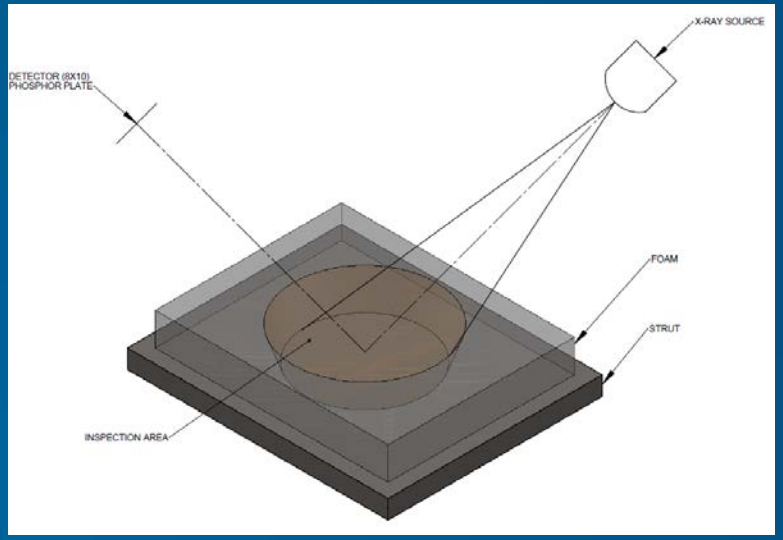


Radiography

- Radiography is often used for imaging
- Radiography generally comprises:
  - Transmission
  - Backscatter
- Transmission is a 2-sided technique

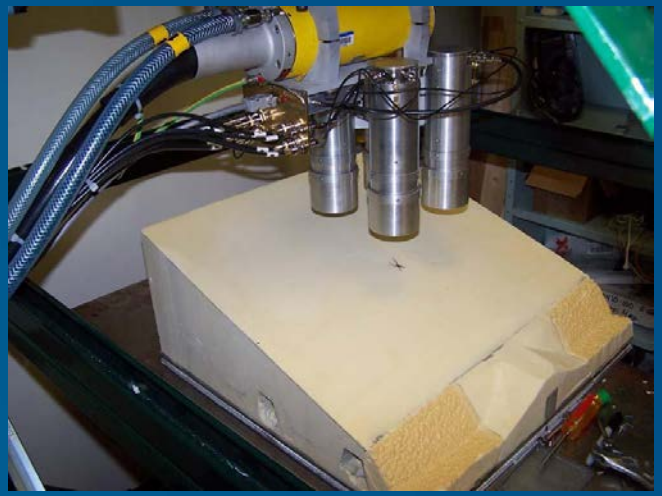
Backscatter Radiography

- **One-sided technique**

- **Conventional technique:**
  - **Based on single-scatter detected to form image**
  - **Higher-order scattering is considered noise**

- Conventional backscatter scanning systems:
  - Highly collimated x-ray beams and detectors
  - Uncollimated x-ray beams and large area detectors

Radiography by Selective Detection (RSD) University of Florida/ NUCSAFE, Inc.



- Highly collimated x-ray beams required
- Relatively steep angles are required for imaging
- Scanning head (array of detectors/x-ray generator) sweeps a line at a time
- Image acquisition is a very time-consuming process

ARIBEX INNOVATION

Advantages

- **Rotationally movable system**

- **A cone-beam x-ray source is used, allowing:**
  - **Simultaneous image data collection**
  - **Large field of view**
  - **Reduce data collection time**
- **Collection of 2D images 360^{o} around the object to be imaged**

- **A 3D-processing computer model – under development**

- **Patent - pending**

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The proposed framework

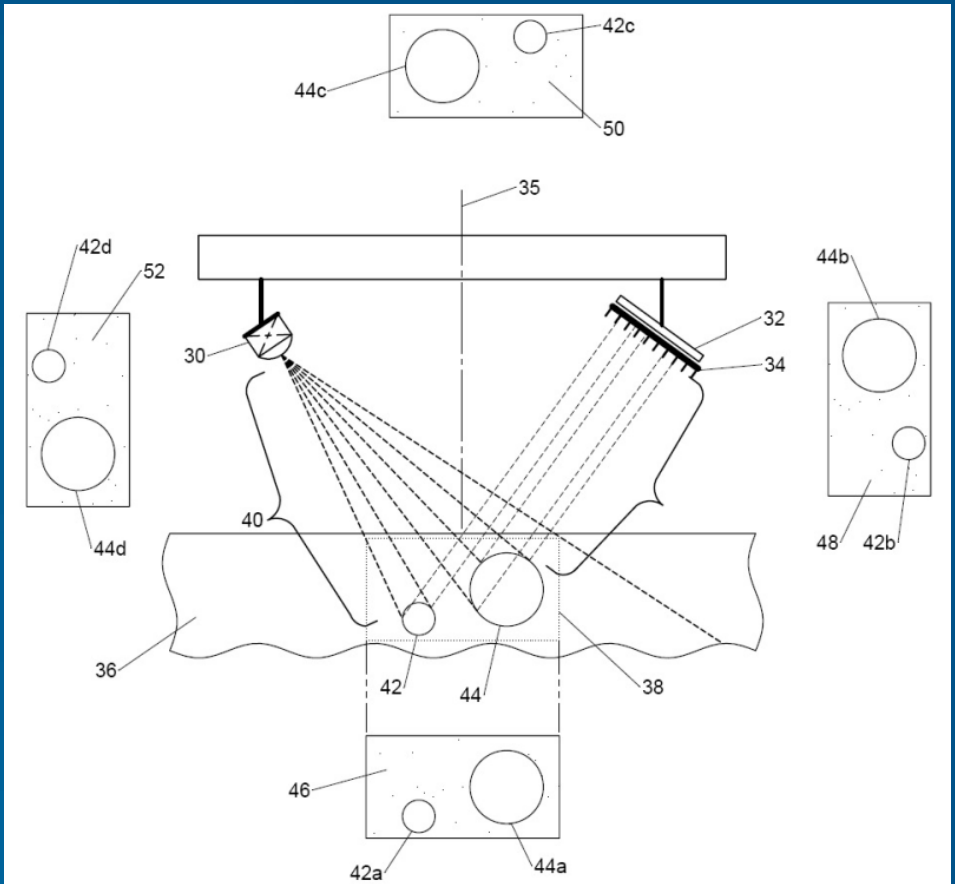

FIG. 2a

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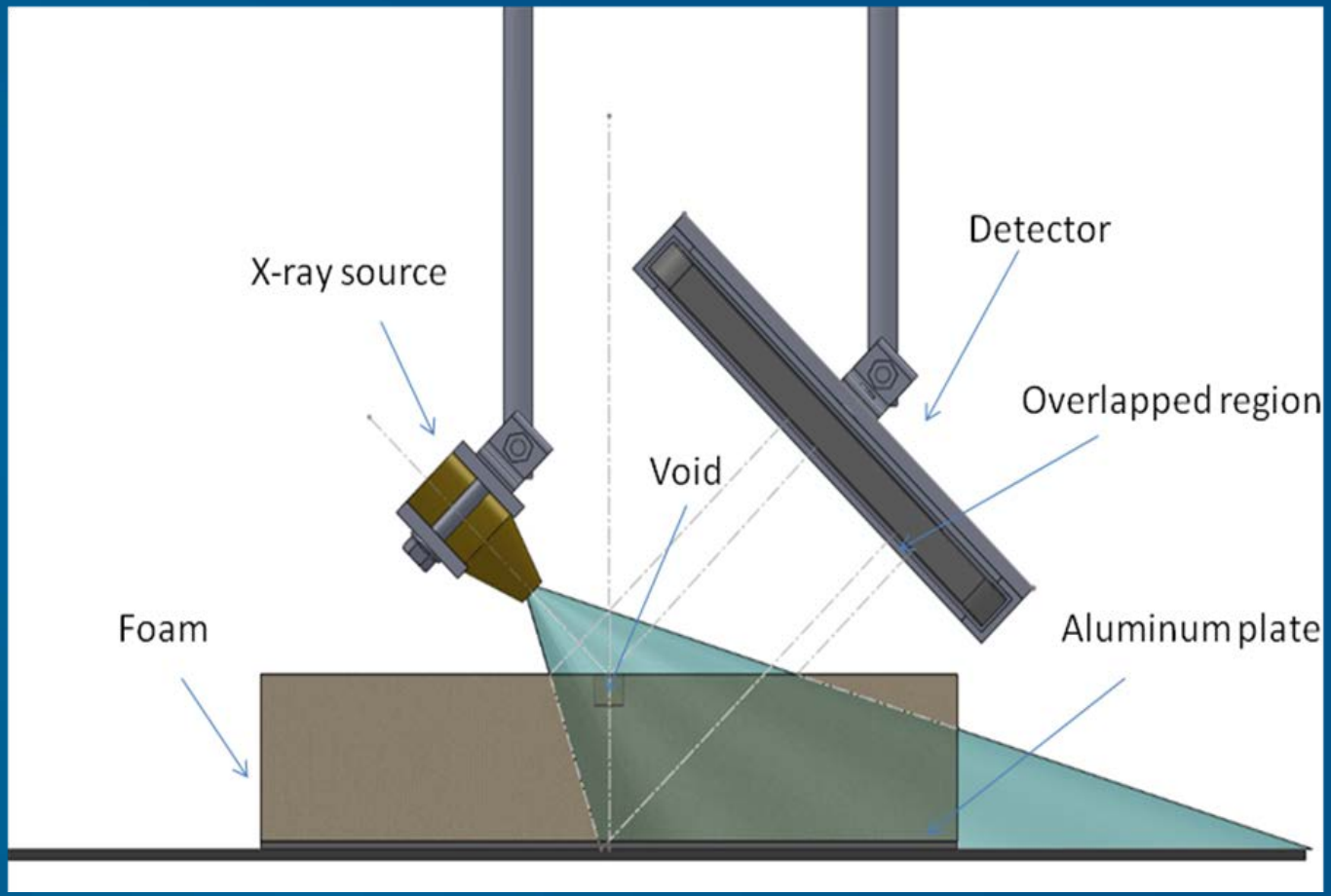
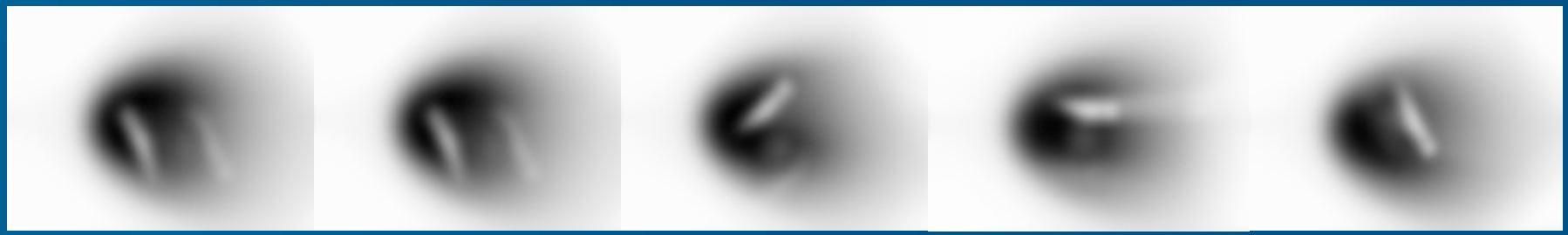
A mockup of initial setup

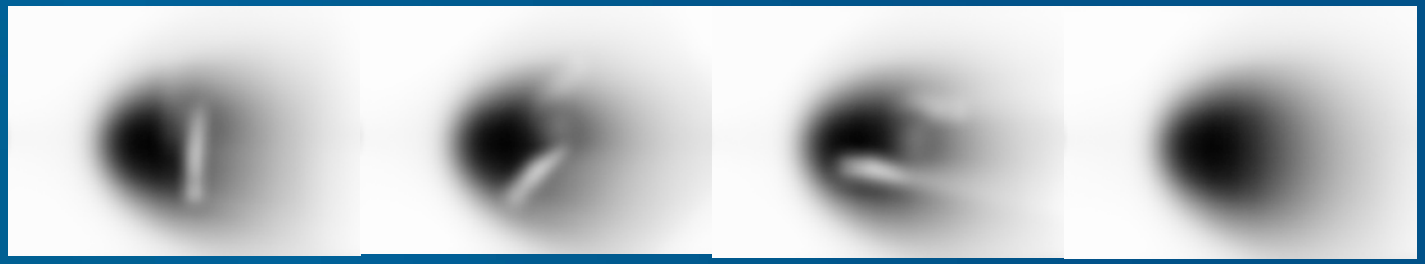


ARIBEX INNOVATION

Multiples images of a void-in-acrylic with metallic objects using initial system setup



310º 270º 220º 180º 130º



90º 40º 0º Background at 0º

ARIBEX INNOVATION

Typical void-in-foam images taken with initial system setup

350º 310º 270º 230º 190º

150º 110º 70º 30º 0º

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Improvements to initial system design

- Brighter x-ray source
- Wider x-ray source cone beam
- A digital detector (instead of a Photostimulated Plate (PSP) used in the initial setup)
- Stacked collimator for better resolution
- System automation for use in a more realistic environment

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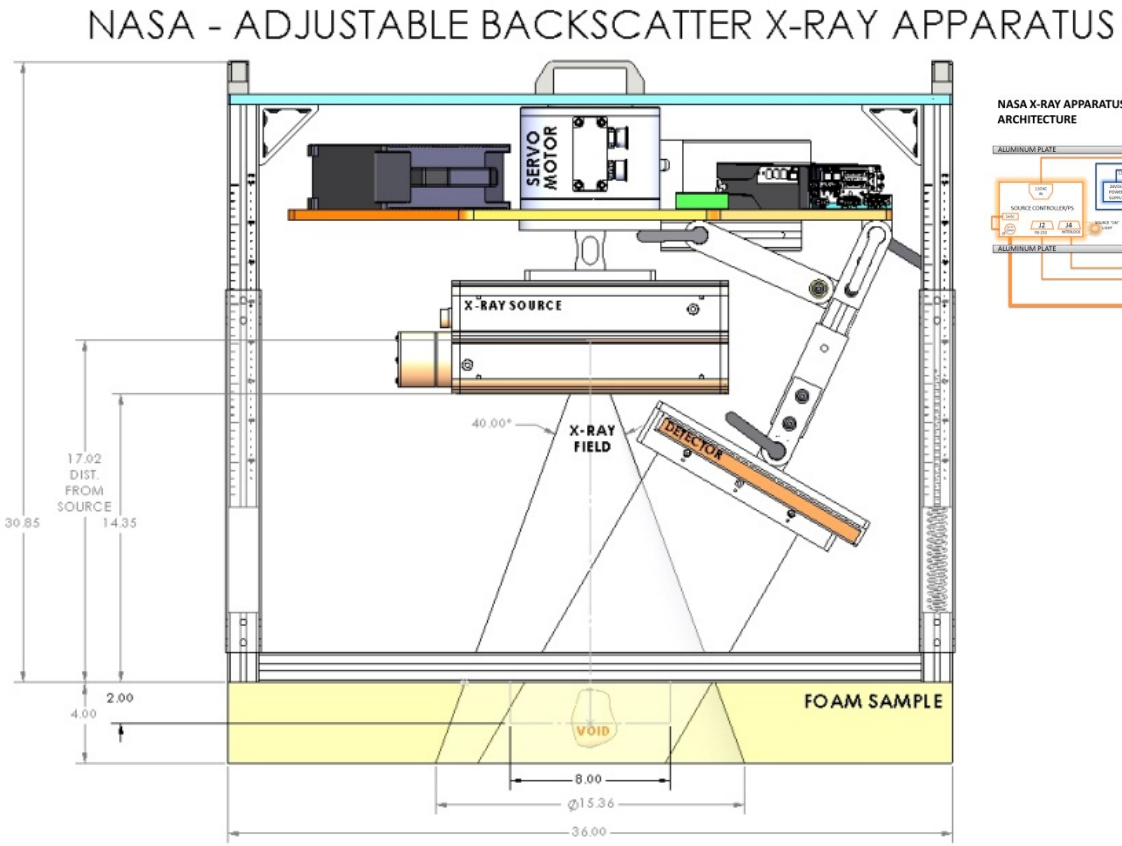
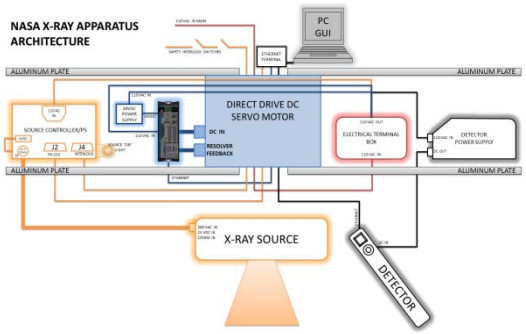
Prototype design





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Simulation and 3D-Reconstruction Computer Model

- Computer model is being developed by the Scientific Computing and Imaging Institute of the University of Utah
- The “Simultaneous Algebraic Reconstruction Technique” (SART) reconstruction algorithm seems to be a good choice for backscatter CT reconstruction
- Currently working on the computer code to improve and account for:
  - Reconstruction algorithms
  - Multiple scattering for the energy range under consideration
  - Inhomogeneities in the cone-beam intensity

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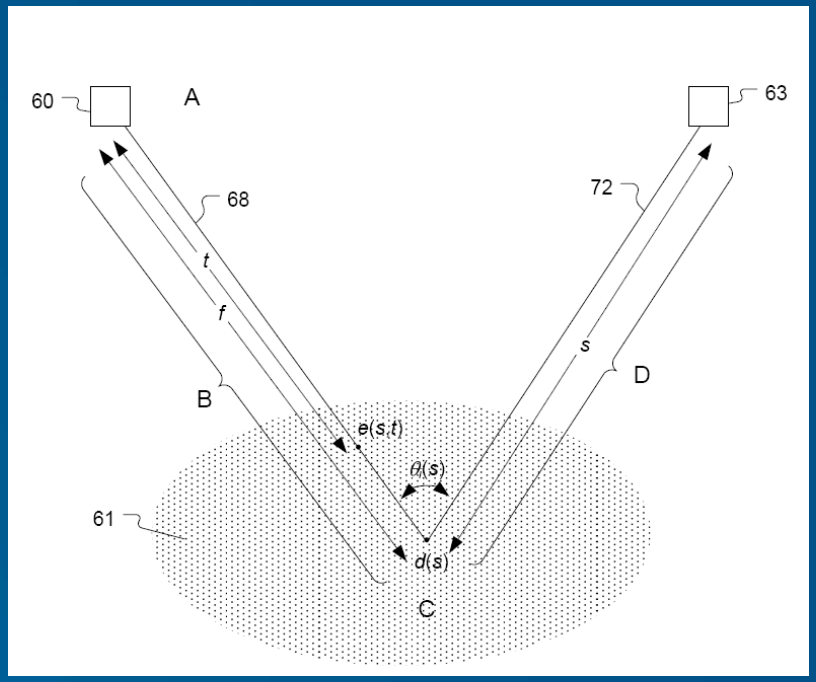
Simulation and 3D-Reconstruction Computer Model

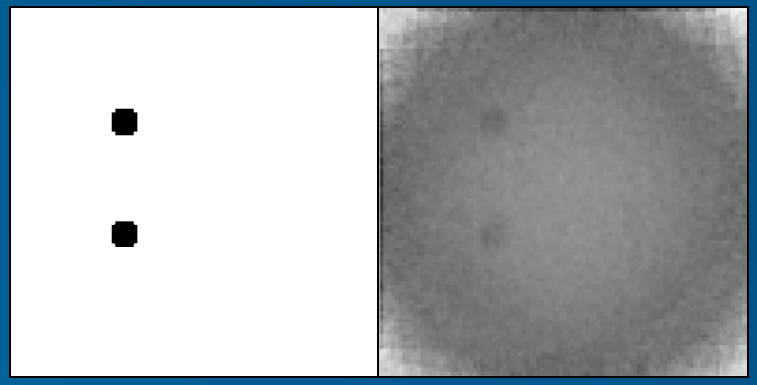


- Internal path absorption of incoming x rays
- Integration of backscattering events exiting the material
- Accounting for path absorption of outbound backscattering
- Detection in individual pixels

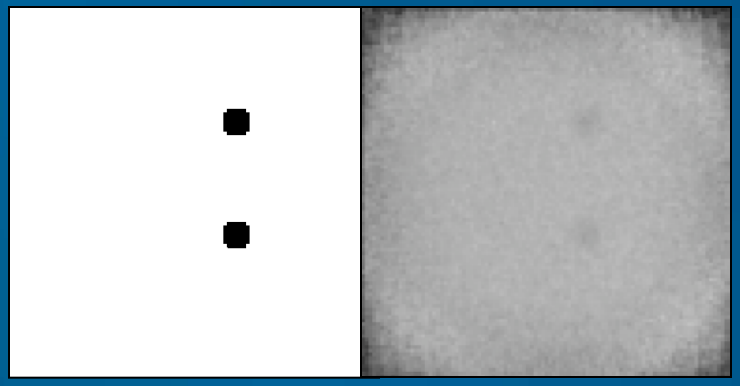
ARIBEX INNOVATION

Simulation and 3D-Reconstruction Computer Model

Illustration of the resolution of the simulated backscatter CT



Original (4mm, 20mm deep) – Reconstruction



Original (4mm, 40mm deep) – Reconstruction

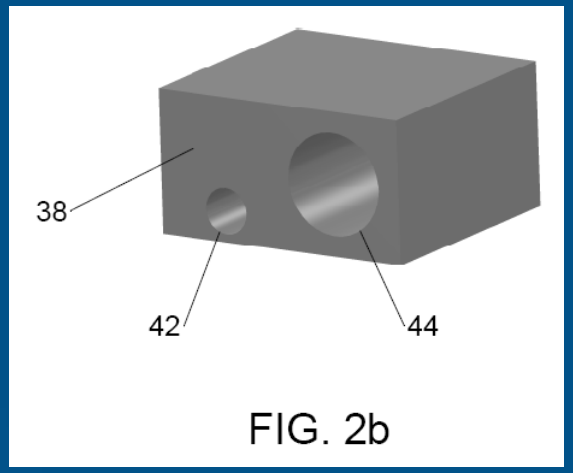
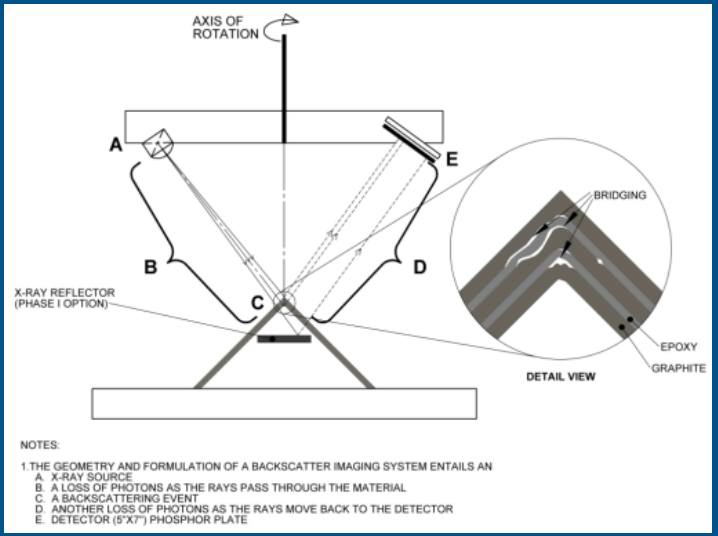
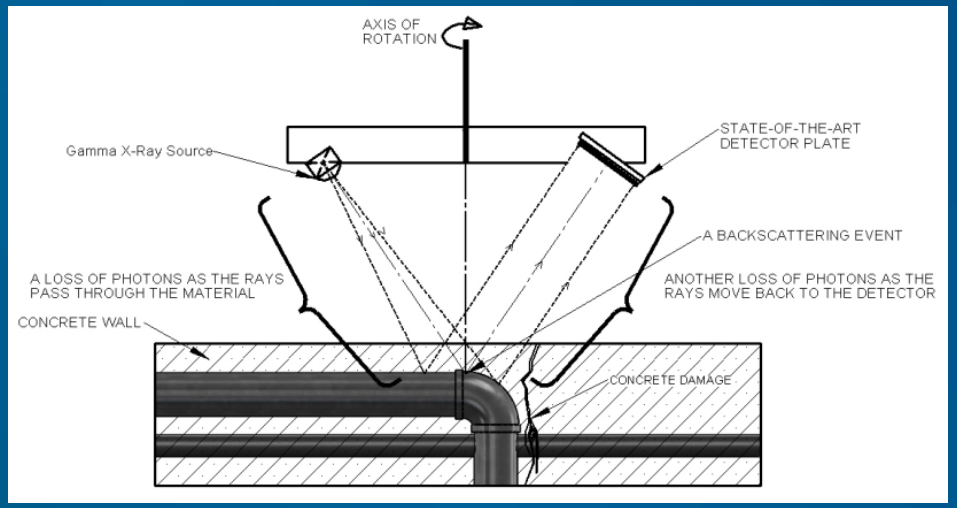


FIG. 2b

OTHER POTENTIAL APPLICATIONS

- Aeronautics
- Cargo Inspection
- NDT and explosive detection
- Construction and Related Industries





SUMMARY

- ARIBEX proposed innovation is an alternative for one-side backscatter 3D imaging
- Proof of concept for 2D images has been achieved
- 3D-reconstruction simulations results are encouraging
- A system prototype design has been completed
- Other potential applications

www.aribex.com